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PCT

NOTIFICATION OF TRANSMITTAL
OF COPIES OF TRANSLATION
OF THE INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY
(CHAPTER I OR CHAPTER II
OF THE PATENT COOPERATION TREATY)
(PCT Rule 72.2)

To:

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Applicant's or agent's file reference JJP03-9147	IMPORTANT NOTIFICATION
International application No. PCT/JP2003/015431	International filing date (day/month/year) 02 December 2003 (02.12.2003)
Applicant S.E.S. CO., LTD. et al	

1. Transmittal of the translation to the applicant.

The International Bureau transmits herewith a copy of the English translation made by the International Bureau of the international preliminary examination report established by the International Preliminary Examining Authority.

2. Transmittal of the copy of the translation to the elected Offices.

The International Bureau notifies the applicant that copies of that translation have been transmitted to the following elected Offices requiring such translation:

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3. Reminder regarding translation into (one of) the official language(s) of the elected Office(s).

The applicant is reminded that, where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report.

It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned (Rule 74.1). See Volume II of the PCT Applicant's Guide for further details.

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Translation

PATENT COOPERATION TREATY

PCT/JP2003/015431



PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY (Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference JJP03-9147	FOR FURTHER ACTION See Form PCT/IPEA/416	
International application No. PCT/JP2003/015431	International filing date (day/month/year) 02 December 2003 (02.12.2003)	Priority date (day/month/year) 12 August 2003 (12.08.2003)
International Patent Classification (IPC) or national classification and IPC H01L 21/304		
Applicant S.E.S. CO., LTD.		

- This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 3 sheets, including this cover sheet.
- This report is also accompanied by ANNEXES, comprising:
 - ☒ (sent to the applicant and to the International Bureau) a total of 8 sheets, as follows:
 - ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
 - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
 - ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) _____, containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

- This report contains indications relating to the following items:

- ☒ Box No. I Basis of the report
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

Date of submission of the demand 08 March 2005 (08.03.2005)	Date of completion of this report 01 June 2005 (01.06.2005)
Name and mailing address of the IPEA/JP	Authorized officer
Facsimile No.	Telephone No.

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/JP2003/015431

Box No. I Basis of the report

1. With regard to the language, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

- ☐ This report is based on translations from the original language into the following language _____, which is language of a translation furnished for the purpose of:
- ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the elements of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

- ☐ The international application as originally filed/furnished
- ☒ the description:
- pages _____ 1-6,12-24 _____, as originally filed/furnished
- pages* _____ 7-11 _____ received by this Authority on _____ 08 March 2005 (08.03.2005)
- pages* _____ received by this Authority on _____
- ☒ the claims:
- pages _____ 8 _____, as originally filed/furnished
- pages* _____, as amended (together with any statement) under Article 19
- pages* _____ 2-4,6,7,9 _____ received by this Authority on _____ 08 March 2005 (08.03.2005)
- pages* _____ received by this Authority on _____
- ☒ the drawings:
- pages _____ 1/11-11/11 _____, as originally filed/furnished
- pages* _____ received by this Authority on _____
- pages* _____ received by this Authority on _____
- ☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☒ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☒ the claims, Nos. _____ 1,5 _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to sequence listing (*specify*): _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to sequence listing (*specify*): _____

* If item 4 applies, some or all of those sheets may be marked "superseded."

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/JP03/15431

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Claims	2-4, 6-9	YES
	Claims		NO
Inventive step (IS)	Claims	2-4, 6-9	YES
	Claims		NO
Industrial applicability (IA)	Claims	2-4, 6-9	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)**Claims 2-4**

None of the documents cited in the ISR describes a substrate treating method, in which (1) control is made to ensure the relation of $T1 \leq T2 \leq T3 \leq$ the boiling point of an organic solvent, where T1 is the temperature in a steam generating section; T2 is the temperature of the mixed gas consisting of the organic solvent and an inert gas in the range from the steam generating section to a spray nozzle; and T3 is the temperature of the dry gas sprayed from the spray nozzle, and (2) the dry gas sprayed from the spray nozzle is made to contain an organic solvent mist of sub-micron size. This constitution is not considered to be obvious to a person skilled in the art either.

Claims 6-9

None of the documents cited in the ISR describes a substrate treating apparatus, in which (1) control is made to ensure the relation of $T1 \leq T2 \leq T3 \leq$ the boiling point of an organic solvent, where T1 is the temperature in a steam generating section; T2 is the temperature in a first pipe; and T3 is the temperature in a spray nozzle, and (2) the dry gas sprayed from the spray nozzle is made to contain an organic solvent mist of sub-micron size. This constitution is not considered to be obvious to a person skilled in the art either.

IAP20 Rec'd PCT/PTO 09 FEB 2006

surface area expressed by a summation of the mists can be increased by causing the number of mists to increase. When the organic solvent vapor in which the surface area of the entire number of mists is increased is injected to the substrate surface, the organic solvent vapor can cover all water droplets adhering to the substrate, so that the organic solvent can efficiently be substituted for the water droplets.

The first object of the invention is to provide a substrate processing method in which not only high-quality substrate surface processing is realized but in which processing time is also shortened by using dry gas containing micro-size organic solvent mist.

The second object of the invention is to provide a substrate processing method in which not only high-quality substrate surface processing is realized but in which the processing time is shortened by adjusting the concentration of micro-size organic solvent mist in the dry gas.

The third object of the invention is to provide a substrate processing apparatus in which not only high-quality substrate surface processing is realized but in which the processing time is shortened by easily forming the dry gas containing micro-size organic solvent mist.

The fourth object of the invention is to provide a substrate processing apparatus in which not only high-quality substrate surface processing is realized but in which the processing time is shortened by adjusting the concentration of micro-size organic solvent mist in the dry gas.

In order to solve the above problems, the substrate processing method according to claim 2 of the present invention, in which the surface of a substrate is dried by injecting it with dry gas consisting of a mixture of an organic solvent vapor and an inert gas, characterized in that the dry gas is formed by bubbling the inert gas in an organic solvent in a vapor generating unit, wherein the temperature of the vapor generating unit is set at T_1 , the temperature of the mixed gas containing the organic solvent and the inert gas is set at T_2 from the vapor generating unit to a jet nozzle,

and the temperature of the dry gas emitted from the jet nozzle is set at T_3 , the temperatures being controlled such that the following relationship holds: $T_1 \leq T_2 \leq T_3 \leq$ the boiling point of the organic solvent, and the dry gas emitted from the jet nozzle consists of organic solvent mists of submicron size..

According to the substrate processing method described in claim 2, the mixed gas is obtained by bubbling the inert gas in the organic solvent, and the mixed gas is formed out of the inert gas which includes the organic solvent vapor containing the organic solvent mist and organic solvent gas whose concentration is lower than the saturation point. The temperature of the mixed gas is controlled or maintained at constant temperature or gradually increased until the mixed gas is emitted from the jet nozzle. Therefore, the organic solvent is gradually vaporized from the surface of the organic solvent mist as to decrease the diameter of the mist particles during movement and the dry gas including the organic solvent mist of submicron size is easily obtained. Further, since the mist contained in the organic solvent vapor is minimized to submicron size, the number of particles of the organic solvent mist can be increased without increasing the amount of organic solvent to be consumed. Further, although the surface area of the individual mist is decreased, the whole surface area which is the summation of the surface areas of the particular mists can be increased by causing the number of mists to increase. Therefore, since a large amount of mists of submicron size can be emitted onto the substrate surface, a large amount of the organic solvent mist of submicron size is efficiently substituted for the rinsing solution adhering to the substrate. As a result, even if many substrates having a large diameter are loaded in the processing vessel, since the mists of submicron size can rapidly cover spaces between substrates, the processing time can be shortened while the level of drying processing efficiency is improved, and the generation of water marks can be extremely avoided or substantially eliminated in the substrate surface. Further, particle adhesion is eliminated and the speed of drying processing is increased, so

that re-adhesion of particles can be prevented.

The invention according to claim 3 of the subject application is a substrate processing method in which a substrate surface is dried by injecting dry gas containing a mixture of an organic solvent vapor and an inert gas to a substrate, the substrate processing method characterized in that the dry gas comprising a mixture of inert gas and the organic solvent vapor is further diluted with dilution gas of the same kind of inert gas, the mixed gas being formed by bubbling the inert gas in an organic solvent in a vapor generating unit, wherein the temperature in the vapor generating unit is set at T_1 , the temperature of the mixed gas is set at T_2' from the vapor generating unit until the mixed gas is diluted with the dilution gas, the temperature of the dilution gas is set at T_4 , the temperature of the mixed gas containing the organic solvent and the inert gas is set at T_2'' to the jet nozzle after the mixed gas is diluted with the dilution gas, and the temperature of the dry gas emitted from the jet nozzle is set at T_3 , and the temperatures are controlled such that the following relationship holds: $T_1 \leq T_2' \leq T_4 \leq T_2'' \leq T_3 \leq$ boiling point of organic solvent, and the organic solvent mist of submicron size is included in the dry gas emitted from the jet nozzle.

According to the substrate processing method described in claim 3, the mixed gas formed in the vapor generating unit out of the inert gas and the organic solvent vapor containing the organic solvent mist and the organic solvent gas whose concentration is lower than saturation point, is further diluted with additional dilution gas of the same kind of inert gas used in the bubbling. The concentration of organic solvent vapor is further reduced in the mixed gas while the possibility of the organic solvent mist being condensed diminishes, and the IPA mist can be carried between the wafers. Therefore, since temperature is controlled such that the mixed gas is kept at constant temperature or gradually increased until the mixed gas is emitted from the jet nozzle, the speed and efficiency with which a part of the organic solvent is vaporized from the surface of the organic solvent mist to become the micro mist are increased, and the large amount

of dry gas containing the organic solvent mist of submicron size is obtained while the concentration thereof remains low, which allows a large quantity of the organic solvent mist of submicron size to be continuously injected to the substrate surface. Even if many substrates having a large diameter are loaded in the processing vessel, since the mist of submicron size can rapidly invade the gaps between substrates, the continuously supplied large amounts of organic solvent vapor of submicron size are rapidly substituted for the rinsing solution adhering to the substrate. As a result, the processing time can be shortened while the level of drying processing efficiency is improved, and acceleration of the drying processing is likewise achieved. Accordingly, the processing time can be shortened while the level of drying processing efficiency is improved without increasing the amount of organic solvent consumed, and the generation of water marks can be extremely avoided or substantially eliminated in the substrate surface. Further, particle adhesion is eliminated and the speed of drying processing is increased, so that re-adhesion of the particle can be prevented.

In the substrate processing method described in either of claims 2 or 3, the invention according to claim 4 of the subject application is characterized in that the organic solvent is at least one kind selected from a group including isopropyl alcohol, diacetone alcohol, 1-methoxy-2-propanol, ethyl glycol, 1-propanol, 2-propanol, and tetrahydrofuran, and the inert gas is at least one kind selected from a group including nitrogen, argon, and helium.

According to the substrate processing method described in claim 4, the selection width of the organic solvent and the inert gas is broadened, and the substrate processing apparatus can be applied to various kinds of the substrate processing by an arbitrary combination.

The substrate processing apparatus according to claim 6 of the invention refers to a substrate processing apparatus comprises a vapor generating unit which generates a mixture of an organic solvent vapor and an inert gas by bubbling the inert gas in an organic solvent; support

means for supporting a plurality of substrates to be vertically arranged in parallel at equal pitches; a rinsing processing vessel which accommodates the plurality of substrates supported by the support means; a lid for covering the upper opening of the rinsing processing vessel; jet nozzles which are provided in the lid; and first piping which allows the vapor generating unit and the jet nozzles to communicate with each other, the substrate processing apparatus characterized in that the first piping and the jet nozzles are respectively equipped with heaters, wherein the temperature in the vapor generating unit is set at T_1 , the temperature in the first piping is set at T_2 , and the temperature in the jet nozzle is set at T_3 , and the temperatures are controlled by the respective heaters such that the following relationship holds: $T_1 \leq T_2 \leq T_3 \leq$ boiling point of organic solvent, and the organic solvent mist of submicron size is included in the dry gas emitted from the jet nozzle.

According to the substrate processing apparatus described in claim 6, the dry gas including the organic solvent of submicron size can easily be formed by controlling the heaters at appropriate locations, and thus the substrate processing apparatus which can easily carry out the substrate processing method described in claim 2.

According to claim 7 of the invention, the substrate processing apparatus comprises a vapor generating unit which generates a mixed gas of an organic solvent vapor and an inert gas by bubbling the inert gas in an organic solvent; support means for supporting a plurality of substrates to be vertically arranged in parallel at equal pitches; a rinsing processing vessel which accommodates multiple substrates supported by the support means; a lid for covering the upper opening of the rinsing processing vessel; jet nozzles which are provided in the lid; and first piping which allows the vapor generating unit and the jet nozzles to communicate with each other, the substrate processing apparatus characterized in that a second piping is provided and connected to the middle portion of the first piping for supplying dilution gas of the same kind of inert gas, whereby the first piping, the second piping, and the jet nozzles are respectively

equipped with heaters, wherein the temperature in the vapor generating unit is set at T_1 , the temperature in the first piping is set at T_2' from the vapor generating unit to the point at which it is connected with the second piping, the temperature in the second piping is set at T_4 , the temperature in the first piping is set at T_2'' the point at which it is connected with the second piping to the nozzle, and the temperature in the jet nozzle is set at T_3 , and the temperatures are controlled by the respective heaters such that the following relationship holds: $T_1 \leq T_2' \leq T_4 \leq T_2'' \leq T_3 \leq \text{boiling point of organic solvent}$, and the organic solvent mist of submicron size is part of the dry gas emitted from the jet nozzle.

According to the invention of the substrate processing apparatus described in claim 7, the substrate processing apparatus can easily carry out the substrate processing method described in claim 3.

According to claim 8 of the invention, the substrate processing apparatus described in claim 7 is further characterized in that a static mixer is provided downstream from the point of connection between the first piping and the second piping and upstream in respect of the jet nozzle.

According to the substrate processing apparatus described in claim 8, in the substrate processing apparatus described in claim 7, since the static mixer is provided downstream from the point of connection between the first piping and the second piping and upstream in respect of the jet nozzle, the inert gas, the organic solvent mist, and the organic solvent gas are sufficiently mixed to obtain a homogeneous mixed gas. Therefore, the formation efficiency of the micro mist is improved.

According to claim 9 of the invention, the substrate processing apparatus described in any one of claims 6 to 8, is characterized in that the organic solvent is at least one kind selected from a group including isopropyl alcohol, diacetone alcohol, 1-methoxy-2-propanol, ethyl glycol, 1-propanol, 2-propanol, and tetrahydrofuran, and the inert gas is at least one kind selected from a group including nitrogen, argon, and helium.

According to the substrate processing apparatus described in claim 9, the selection width of the organic solvent and the inert gas is broadened,

and the substrate processing apparatus can be applied to various kinds of substrate processing by any arbitrary combination.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view showing a substrate processing apparatus according to an embodiment of the invention;

Fig. 2 is a side view showing a processing vessel referred to in the embodiment of the invention;

Fig. 3 is a side view showing the processing vessel of Fig. 2 when viewed from the opposite side;

Fig. 4 is a plane phantom view of the processing vessel referred to in the embodiment of the invention when viewed from an upper portion of the lid thereof;

Fig. 5 is a side view of the lid illustrated in Fig. 4;

Fig. 6 is a view showing a timing chart of a series of processing steps;

Fig. 7 shows a cleaning and drying process, Fig. 7(a) is a sectional view illustrating the cleaning process, Fig. 7(b) is a sectional view illustrating the drying process 1, Fig. 7(c) is a sectional view illustrating the drying process 2, and Fig. 7(d) is a sectional view illustrating the drying process 3;

CLAIMS

1. (Delete)

2. (After amendment) A substrate processing method in which a substrate surface is dried by injecting it with dry gas comprising a mixture of an organic solvent vapor and an inert gas,

the substrate processing method characterized in that the dry gas is a mixture of inert gas and the organic solvent vapor, wherein the mixed gas is formed by bubbling the inert gas in an organic solvent in a vapor generating unit,

wherein the temperature in said vapor generating unit is set at T_1 ,

the temperature of the mixed gas containing the organic solvent and the inert gas is set at T_2 from the vapor generating unit to a jet nozzle, and

the temperature of the dry gas emitted from the jet nozzle is set at T_3 ,

and the temperatures are controlled such that the following relationship holds:

$T_1 \leq T_2 \leq T_3 \leq$ boiling point of organic solvent, and

the organic solvent mist of submicron size is part of the dry gas emitted from said jet nozzle.

3. (After amendment) A substrate processing method in which a substrate surface is dried by injecting it with dry gas containing a mixture of an organic solvent vapor and an inert gas,

the substrate processing method characterized in that the dry gas containing the mixture of inert gas and the organic solvent vapor is further diluted with dilution gas of the same kind of inert gas, wherein the mixed gas is formed by bubbling the inert gas in an organic solvent in a vapor generating unit,

wherein the temperature in the vapor generating unit is set at T_1 ,

the temperature of the mixed gas is set at T_2' from the vapor

generating unit until the mixed gas is diluted with the dilution gas,

the temperature of the dilution gas is set at T_4 ,

the temperature of the mixed gas containing the organic solvent and the inert gas is set at T_2'' to the jet nozzle after the mixed gas is diluted with the dilution gas, and

the temperature of the dry gas emitted from the jet nozzle is set at T_3 ,

and the temperatures are controlled such that the following relationship holds:

$T_1 \leq T_2' \leq T_4 \leq T_2'' \leq T_3 \leq \text{boiling point of organic solvent}$, and

the organic solvent mist of submicron size is included in the dry gas emitted from the jet nozzle.

4. (After amendment) A substrate processing method according to claim 2 or claim 3, characterized in that the organic solvent is at least one kind selected from a group including isopropyl alcohol, diacetone alcohol, 1-methoxy-2-propanol, ethyl glycol, 1-propanol, 2-propanol, and tetrahydrofuran, and said inert gas is at least one kind selected from a group including nitrogen, argon, and helium.

5. (Delete)

6. (After amendment) A substrate processing apparatus including:

a vapor generating unit which generates a mixed gas of an organic solvent vapor and an inert gas by bubbling the inert gas in an organic solvent;

support means for supporting a plurality of substrates vertically arranged in parallel at equal pitches;

a rinsing processing vessel which accommodates the plurality of substrates supported by the support means;

a lid for covering the upper opening of said rinsing processing vessel;

jet nozzles which are provided in the lid; and

first piping which allows the vapor generating unit and the jet nozzles to communicate with each other,

the substrate processing apparatus characterized in that the first piping and the jet nozzles are respectively equipped with heaters,

wherein the temperature in the vapor generating unit is set at T_1 ,

the temperature in the first piping is set at T_2 , and

the temperature in the jet nozzle is set at T_3 ,

and the temperatures are controlled by the respective heaters such that the following relationship holds:

$T_1 \leq T_2 \leq T_3 \leq$ boiling point of organic solvent, and

the organic solvent mist of submicron size is part of the dry gas emitted from the jet nozzle.

7. (After amendment) A substrate processing apparatus including:

a vapor generating unit which generates a mixed gas of an organic solvent vapor and an inert gas by bubbling the inert gas in an organic solvent;

support means for supporting a plurality of substrates vertically arranged in parallel at equal pitches;

a rinsing processing vessel which accommodates the plurality of substrates supported by the support means;

a lid for covering the upper opening of said rinsing processing vessel;

jet nozzles which are provided in the lid; and

first piping which allows the vapor generating unit and the jet nozzles to communicate with each other,

the substrate processing apparatus characterized in that a second piping is provided and connected to the middle portion of the first piping for the purpose of supplying dilution gas of the same kind of inert gas,

the first piping, the second piping, and the jet nozzles are

respectively equipped with heaters,

wherein the temperature in the vapor generating unit is set at T_1 ,
the temperature in the first piping is set at T_2' from the vapor
generating unit to the point in which it is connected with the second piping,
the temperature in the second piping is set at T_4 ,
the temperature in the first piping is set at T_2'' from the point in
which it is connected with the second piping to the nozzle, and
the temperature in the jet nozzle is set at T_3 ,
and the temperatures are controlled by the respective heaters such
that the following relationship holds:

$$T_1 \leq T_2' \leq T_4 \leq T_2'' \leq T_3 \leq \text{boiling point of organic solvent, and}$$

the organic solvent mist of submicron size is part of the dry gas
emitted from said jet nozzle.

8. A substrate processing apparatus according to claim 7,
characterized in that a static mixer is provided downstream from the point of
connection between the first piping and the second piping and upstream in
respect of the jet nozzle.

9. (After amendment) A substrate processing apparatus described in
any one of claims 6 to 8, characterized in that the organic solvent is at least
one kind selected from a group including isopropyl alcohol, diacetone alcohol,
1-methoxy-2-propanol, ethyl glycol, 1-propanol, 2-propanol, and
tetrahydrofuran, and said inert gas is at least one kind selected from a group
including nitrogen, argon, and helium.